Eliciting and Specifying Quality Attribute Requirements

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What we'll discuss today

Quality Attributes

Eliciting Quality Attribute Requirements

Quality Attribute Workshop

Quality Attribute Scenarios

I'll take questions at the end of the presentation.

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Polling Question

When is the best time to specify quality attribute (non-functional) requirements?

1. After the software architecture is established
2. Before the software architecture is established
3. Quality attributes are not important

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What are Quality Attributes?

Measurable or testable properties of a system used to indicate how well the system satisfies the needs of its stakeholders

Here are some examples of quality attributes:

- availability
- configurability
- modifiability
- performance
- reliability
- reusability
- security
- throughput

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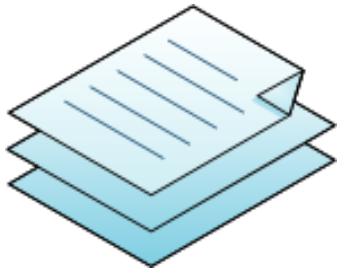
Stakeholders and Quality Attributes

Lead To



Stakeholder Needs

Quality Attribute Requirements

"Increase market share" ----------> Modifiability, Usability

"Maintain a quality reputation" ----------> Performance, Usability, Availability

"Introduce new capabilities seamlessly" ----------> Performance, Availability, Modifiability

"Provide a programmer-friendly framework" ----------> Modifiability

"Integrate with other systems easily" ----------> Interoperability, Portability, Modifiability

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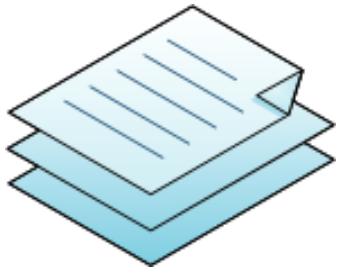
Quality Attributes and Architecture

The degree to which a system satisfies quality attribute requirements is directly dependent on architectural structure.



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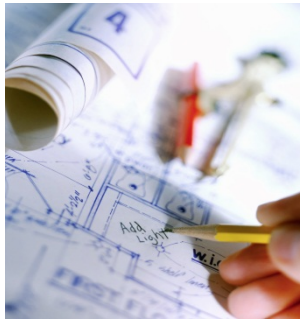

Quality Attribute Requirements

Software Architecture Design

Consequently, architects need to have a solid understanding of the quality attribute requirements for a system when they are designing the system's software architecture.

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Polling Question

What approach does your organization use to specify quality attribute requirements?

1. We ask management what they think the system should do.
2. We discuss the system's quality attributes once the system is designed.
3. We use a method to gather the views of all our stakeholders early in the development life cycle.
4. We don't worry about quality attributes.

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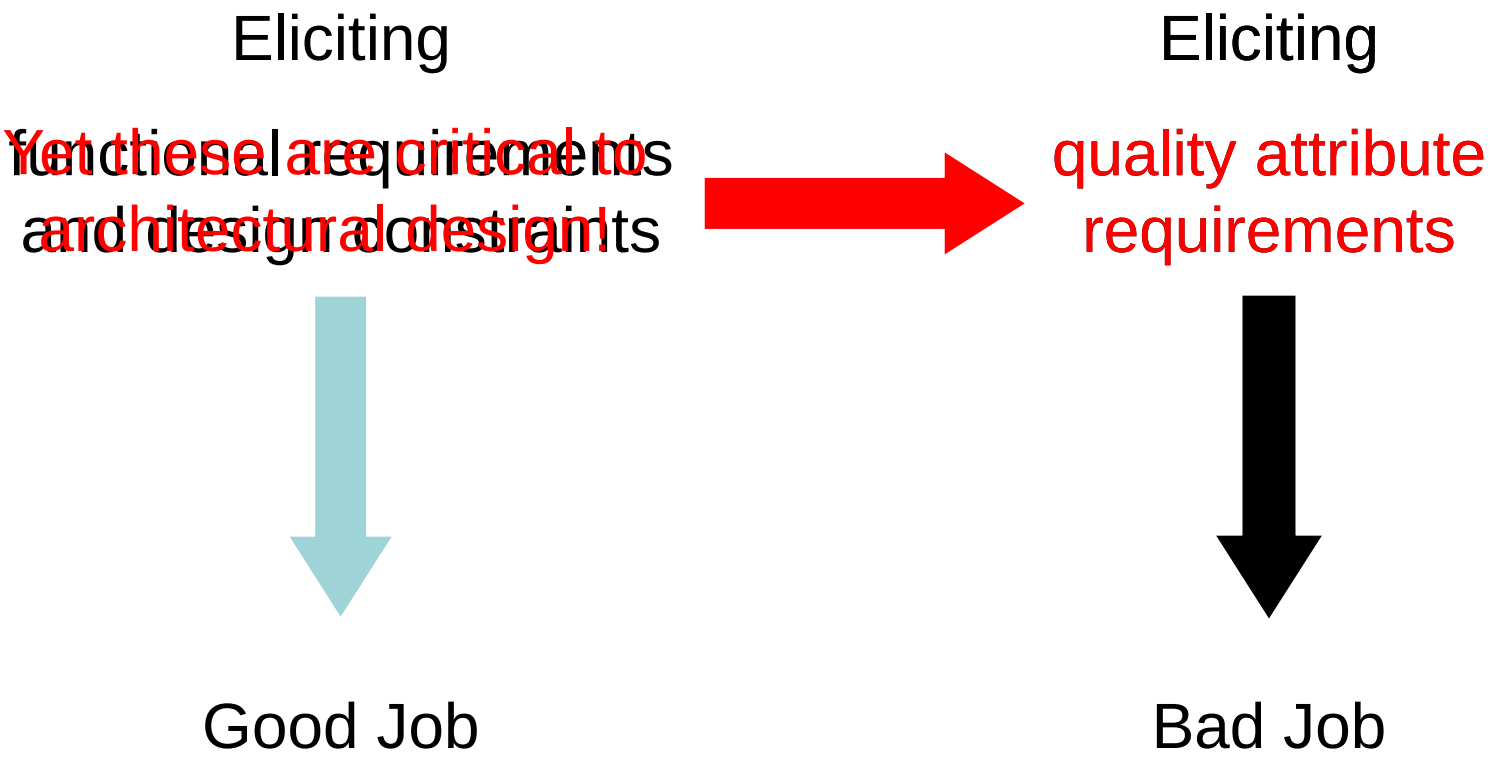
Eliciting Quality Attribute Requirements



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Problems With Quality Attribute Requirements

Non-Operational requirements

- “The system must be easy to use.”
- “The system must have high performance.”
- “The system must be portable.”

Debating the quality attribute to which a system behavior belongs

- “The system must process 10,000 messages per second.”

Vocabulary variations

- Everyone knows what “high performance” means, right?

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Quality Attribute Workshop (QAW)

Facilitated method

- system-centric
- used before the software architecture has been created

Engages system stakeholders early in the life cycle

Reveals the driving quality attribute requirements of a software-intensive system

- scenario based

A QAW delivers the quality attribute requirements for the system, documented as refined and prioritized quality attribute scenarios

The quality attribute scenarios can then be used as the basis for designing the software architecture for the system.

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QAW Steps

1. QAW Presentation and Introductions
2. Business/Programmatic Presentation
3. Architectural Plan Presentation
4. Identification of Architectural Drivers
5. Scenario Brainstorming
6. Scenario Consolidation
7. Scenario Prioritization
8. Scenario Refinement

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Today's focus

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Step 4: Identification of Architectural Drivers

The QAW facilitators identify the architectural drivers that are key to realizing quality attribute goals by

- presenting a distilled list of the architectural drivers they heard during the Business/Programmatic and Architecture Plan presentations
- asking for clarifications, additions, or deletions to reach a consensus on the architectural drivers

The final list of architectural drivers focuses the stakeholders during scenario brainstorming.

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Step 5: Scenario Brainstorming

Stakeholders generate scenarios using a facilitated brainstorming process.

Each stakeholder either generates a scenario in round-robin fashion or opts to pass.

Each stakeholder may have an opportunity to contribute more than one scenario, depending on the number of stakeholders in the QAW and the allocated time for the workshop.

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Step 5: Scenario Brainstorming

Scenario brainstorming guidance

- Quality attribute requirements are most effectively characterized vis-à-vis scenarios.
- Scenarios are "short stories" that describe a system interaction with respect to some quality attribute.
- Well-formed scenarios have a stimulus, an environment, and a response.
- The QAW focuses on three kinds of scenarios:
  - use case – anticipated uses of the system
  - growth – anticipated changes to the system
  - exploratory – unanticipated stresses to the system (uses and/or changes)

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Stimuli, Environment, Responses

Use case scenario

> *A remote user requests a database report via the Web* **during a peak period** and receives it within 5 seconds.

Growth scenario

> *Add a new data server* **to reduce latency in the use case scenario to 2.5 seconds** within 1 person-week.

Exploratory scenario

> *Half of the servers go down* **during normal operation** without affecting overall system availability.

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Step 6: Scenario Consolidation

The QAW facilitators ask stakeholders to identify those scenarios that are very similar in content.

- Similar scenarios are merged to prevent a “dilution” of votes when voting is done in the next step.
- QAW facilitators attempt to reach a consensus with the stakeholders before merging scenarios.

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Step 6: Scenario Consolidation

Example of scenario consolidation

Scenarios that are similar in content are grouped together.

- In the event of a processor fault, the system can be rebooted/reinitialized.
- A processor failure or crash doesn't adversely affect any other components (no second-order failures).
- Software continues to operate even if the host fails (mission computer).

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Step 7: Scenario Prioritization

Each stakeholder is allocated a number of votes equal to approximately 30% of the number of scenarios generated.

- The actual number of votes allocated to stakeholders is rounded up to an even number of votes.
- Voting occurs in two rounds where each stakeholder allocates exactly half of his or her total votes in each round.
- Stakeholders can allocate any number of votes to any scenario they like.
- Votes are counted, and the scenarios are prioritized accordingly.

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Step 8: Scenario Refinement

The top scenarios are further refined.

- Typically, the top five scenarios are refined, but the exact number will depend on the time available.

The QAW facilitators further elaborate each scenario and

- document the business/programmatic goals affected by the scenario
- describe the relevant quality attributes
- rephrase it in six parts: a stimulus, a stimulus source, an environment, an artifact, a response, and a response measure
- document a list of related questions that stakeholders want to ask
- document any issues that may arise during scenario refinement

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Example Scenario Refinement - 1

Scenario	The track capacity is saturated during peak operations over a large-sized theatre and degrades in a predictable and useful manner.
Business Goals	Mission effectiveness
Quality Attributes	• performance • scalability

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Example Scenario Refinement - 2

Stimulus	Some resource capacity is saturated (or hits high watermark).
Stimulus Source	Network, memory, applications, and so on
Environment	Operational with high load conditions (or battle damage)
Artifact	Track Manager or host system
Response	• throttling appropriately • request for or release of resources
Response Measure	Predictable behavior as appropriate per platform

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Example Scenario Refinement - 3

Questions	What is the track capacity? Is it based on hardware? How do you know it's saturated? In what ways can you degrade the quality of service associated with the tracks? What can be automated? Which architectural decisions apply and support that automation? Which degrade modes do stakeholders want to see implemented?

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Example Scenario Refinement - 4

Issues	We can't size systems *a priori* to eliminate oversaturation. Track Manager needs a way to compensate for saturation in a doctrinally appropriate manner. Open a dialogue with the applications using Track Manager to identify objects of interest, so that applications can have a say in this answer.

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For More Information

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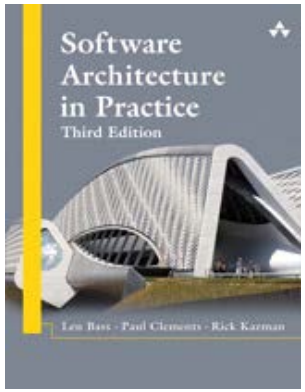
- Find out more about the QAW: www.sei.cmu.edu/architecture/tools/establish/qaw.cfm
- For more about the SEI approach to quality attributes and architecture-centric engineering, start exploring at www.sei.cmu.edu/architecture/



- Also see *Software Architecture in Practice, 3rd edition* written by Len Bass, Paul Clements, & Rick Kazman and published by Addison-Wesley as part of the SEI Series in Software Engineering.
- Visit www.sei.cmu.edu/library/abstracts/books/9780321815736.cfm

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